CONSTRUCTION AGGREGATES — BUILDING BLOCK PROFILE

Prepared for:

Economic Development Branch
BC Ministry of Sustainable Resource Management

With the Generous Support of:

Ministry of Energy and Mines

Prepared by:

Glenn E. Bridges & Associates Inc.

December 2002

BUILDING BLOCKS FOR ECONOMIC DEVELOPMENT & ANALYSIS

PREFACE

PURPOSE

Building Blocks have been conceived and developed by the Economic Development Branch of the Ministry of Sustainable Resource Management, under the guidance of Nancy South, Manager Economic Analysis, as an analytical tool that supports British Columbia coastal and land and resource use planning and decision-making and economic development initiatives. The Blocks contain concise business and sector information for a broad range of resource-based business types in BC. At this point, there are more than 30 Blocks either complete or in draft form. Several more Blocks have been identified as high priority by planning tables and other client groups. Additional Building Blocks will be developed over time, and some Blocks may be updated. For the most current Building Blocks, please see the Ministry of Sustainable Resource Management website, at: http://srmwww.gov.bc.ca/rmd/ecdev/

ACKNOWLEDGEMENTS

Generous support in terms of both funding and staff time has been provided by the Ministries of Energy and Mines; Water, Land and Air Protection; Agriculture, Food and Fish; and Forests, as well as by Skeena and Coast Regions of the Ministry of Sustainable Resource Management.

BENEFITS

Building Blocks are expected to provide the following general benefits:

- Increase efficiency and more informed decision-making by providing readily accessible, credible information to planning and economic development processes;
- Improve the consistency of economic information across planning areas;
- Support economic analysis and decision-making that occurs outside formal coastal and land use planning processes; and
- Provide linkages between economic analysis and other social and environmental analytical tools (through identifying resource requirements to support economic activities and general compatibilities with other sectors and values).

LIMITATIONS

Every effort has been made to ensure that the information contained in Building Blocks is accurate and consistent. Approved, credible data sources are the foundation for Building Blocks. All Blocks were reviewed by sponsoring agencies and other experts. However, users are cautioned that information is used at their own risk, and that the authors and sponsors are not liable for any damages. Any conclusions or interpretations by the authors are not intended to represent government policy. Also, note that Building Blocks do not provide site specific information nor do they consider requirements for sustainability (social, community, environmental).

COPYRIGHT/REFERENCE

These Building Blocks are copyright to the Government of British Columbia, Ministry of Sustainable Resource Management, Economic Development Branch. See http://www.gov.bc.ca/com/copy/ for information regarding the copyright and to request permission to reproduce the Building Block documents.

RECOMMENDED REFERENCE/CITATION

BC Ministry of Sustainable Resource Management, 2003, Building Blocks for Economic Development and Analysis, *[Title of Sector]*. http://srmwww.gov.bc.ca/rmd/ecdev/

TABLE OF CONTENTS

1.0 OVERVIEW 1

1.1 Description 1
1.2 Major Uses 1
1.3 Some Major Sources 2

2.0 RESOURCE SENSITIVITIES 2

2.1 Traditional Operations 2
2.2 Sensitivities 3
2.3 Trends and Implications 3

3.0 INVESTMENT REQUIREMENTS 4

3.1 Investment 4
3.2 Production and Investment Scale 4

4.0 INFRASTRUCTURE 5

4.1 Equipment 5
4.2 Schematic of Self-Unloading Ship 5

5.0 MARKETS 6

5.1 Major Aggregate Users 6
5.2 Quality Specifications 6
5.3 Aggregate Prices 7

6.0 EMPLOYMENT 8

6.1 Total Employment 8

7.0 RESOURCE CAPACITY 8

8.0 REGULATION 9

8.1 Provincial Approvals 9
8.2 Federal Approvals 10
8.3 Local Approvals 10
8.4 Approval Lead Time 10

9.0 GOVERNMENT REVENUES 11

10.0 INPUT-OUTPUT COEFFICIENTS 12

10.1 Demand Coefficients 12
10.2 Employment Coefficients 12

SOURCES OF INFORMATION 13

105-05475/

1.0 OVERVIEW

1.1 Description

- Construction aggregate refers to crushed rock, sand and gravel (washed and unwashed), including unprocessed pit-run aggregate and rip-rap (e.g., larger sized rock for erosion control).
- Construction aggregate consist of clean, uncoated rock and sand particles, which are categorized by size, shape, soundness, hardness, strength and chemical properties, depending upon their intended use.
- Construction aggregates are essential for building and maintaining physical infrastructure (e.g., buildings, roads, bridges, runways, railways, dams, water, sewer systems, etc.)
- Gravel is used for road base, underneath concrete pads, construction fill, drainage and in the manufacture of concrete, concrete building products (e.g., cement pipe, blocks, telephone poles, etc) and for asphalt products – sand is used for mortar, masonry building products, construction fill, golf courses, beach sand, landscaping etc.
- Crushed rock is desirable in asphalt, because the angular rock particles promote intergranular contact and adhesion, which improves bonding strength – rounded aggregate used in concrete improves the workability and pumpability (using concrete pumper trucks), although rounded aggregate reduces the maximum strength of concrete.

1.2 Major Uses

- In BC, most aggregates are used for road construction (e.g., resource roads, public highways – about 60% of commercially produced aggregates are used in public works projects – documented production is about 50 million tonnes/yr., however the Aggregate Producers Association of BC, estimate the amount of aggregate in BC could be as high as 100 million tonnes /yr.[2]

General Use[3]	Percent	Estimated Quantity
		M tonnes/yr.
Forestry Roads	26	13.0
Residential Housing	22	11.0
Public Highways & Streets	20	10.0
Buildings	14	7.0
Dams, Canals, Airports	10	5.0
Landscape & Specialty Sand	5	2.5
Ports, Railroad & Transit Rock	3	1.5
Total[4]	100	50.0
Exports		1.3

- In BC, aggregate production in BC is about 7 metric tonnes per person.[5]

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

1.3 Some Major Sources

Type	Estimated Quantity
	'000 tonnes/yr.
Total intermittent pits and quarries	19,600
Forestry related pits and quarries[6]	17,100
Public pits in highways database[7]	4,500
Commercial pits and quarries[6]	745
Government owned pits[6]	683
Forest company active pits[6]	97
Pits with concrete operations	70
Pits with asphalt operations	34
Other Sources	8,500
Total	51,300

- As estimated in the above table, considerable quantities of aggregate are obtained from intermittent pits and quarries along the network of resource roads and highways throughout BC.
- Aggregates are the chief raw material for Portland cement concrete and asphalt pavement – about 90 to 95 percent of asphalt and about 85 percent of concrete is composed of aggregate.[8]
- Aggregate operations must balance market demand with their supply of sand and gravel – if deficient in gravel (of the required specification) they may have to crush rock (at higher cost) to provide the required balance for their customers.

2.0 RESOURCE SENSITIVITIES

2.1 Traditional Operations

- There are more than 1,500 active pits and quarries in BC – traditionally, aggregate has been mined relatively close to growing urban areas and major construction projects (e.g., roads, airports) – this is because the product is bulky, low in unit value, and expensive to transport – if transported by truck, aggregate is generally used relatively close to the extraction site.
- As urban areas expand to the previously remote aggregate operations, surrounding residents and those who live on the road serving the operation often complain about the social and economic impacts from existing operations (some of which are listed below).

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

2.2 Sensitivities

Social	Economic	Environmental
➤ Noise and vibration from blasting, crushing screening, back-up alarms ➤ Visual aesthetics. ➤ Dust from pit and trucks ➤ Heavy truck traffic safety and noise ➤ Site security and safety.	➤ First Nations rights. ➤ Truck wear on roads serving the operation. ➤ Hours of operation.	➤ Water use and discharges from surface erosion, product washing, and accidental spills. ➤ Groundwater impacts. ➤ Loss of plant cover and topsoil conservation. ➤ Fish and wildlife habitat impacts. ➤ Acid rock drainage.

- Competing land use plans, zoning requirements, and regulations frequently restrict or prohibit extraction of aggregates near populated areas – some municipalities, particularly in the Fraser Valley and on Vancouver Island have introduced bylaws to limit operations.
- The Ministry of Energy and Mines has published a comprehensive handbook to help aggregate operators manage these potential conflicts.[9]

2.3 Trends and Implications

- The trend appears to be toward developing large-scale aggregate operations (e.g., the Alberni crushed rock project), that are located away from large populated areas, which can be accessed by high-volume low-cost delivery means, such barges, deep-sea ocean ship transport or by rail shuttle operations (e.g., in the US).
- Aggregate is being delivered to the Vancouver area by barge from the Sunshine Coast area – for example, the Sechelt First Nation leases land to Lehigh Northwestern Cement Ltd., who operate Canada's largest, 3.5 million tonne/yr, sand and gravel operation near Sechelt. [10]
- In BC, the use of ocean ship transport, as compared to traditional barges, has reduced transport costs and allows economic delivery to relatively distant Pacific Rim markets (e.g. California, Hawaii) – the Sechelt operation began shipping aggregate to the San Francisco Bay area in 2001 and on January 2002, a shipment of golf course sand was sent to Hawaii.[11]
- Greater road hauling distance adds to pollution, road wear, and traffic congestion – since most aggregate is used in public works projects, increased transportation costs are passed on to the public through higher taxes or reduced public services.
- Aggregate operations are a temporary land use – when aggregate operations are completed, proper reclamation can create land for higher-valued uses, such as for residential, commercial or recreational purposes (e.g., Buchart Gardens, Coquitlam Town Center, Sky Train maintenance yards, etc.)[12]

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

3.0 INVESTMENT REQUIREMENTS

3.1 Investment

- Aggregate is typically found in loose, non-cohesive deposits produced by various sedimentary processes (e.g., glacial and water-related erosion and deposition processes) – aggregate deposits are ideal when they contain little or no impurities (e.g. silt, clay), are economic to process and transport to market (e.g., truck, barge or ship).
- Quarried aggregate is typically produced from large granite or basalt deposits – processing involves quarrying, crushing, screening and washing which is generally more costly than pit-run operations.
- The total investment in aggregate production and processing facilities in BC, excluding secondary manufacturing, such as ready mix concrete and asphalt plants is estimated to be about $600 million.
- The large integrated companies supplying the major urban markets have invested more than $10 million in their operations – however, there are also many small producers with a relatively low investment in capital that operate throughout BC.
- Total sales revenues at the pit are about $260.0 million/yr. – overall revenues are about $870.0 million/yr. which represents about 5.0 percent of BC's $17.4 billion per year construction industry.[13]

3.2 Production and Investment Scale

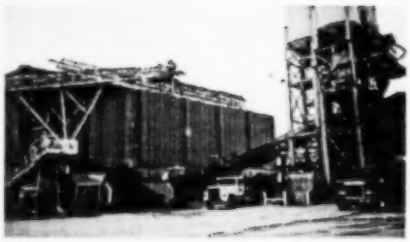
	Crushed Rock	Washed Sand and Gravel	Unwashed Sand & Gravel
	($'000)	($'000)	($'000)
Initial investment (Excludes delivery trucks)	2,000- 30,000	200- 20,000	100- 500
Annual Capital Reinvestment	250-1,000	250-500	10- 100
Total Production **('000 tonnes)**	6,500	32,900	12,000
Number of Companies	50	200	700

- Operational efficiency depends on selling the maximum amount of material from the pit and by processing it so that it can be sold – the profitability of many small operators also depends on property ownership (e.g., to minimize royalties, provide security for debt to finance expansion, etc.).

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

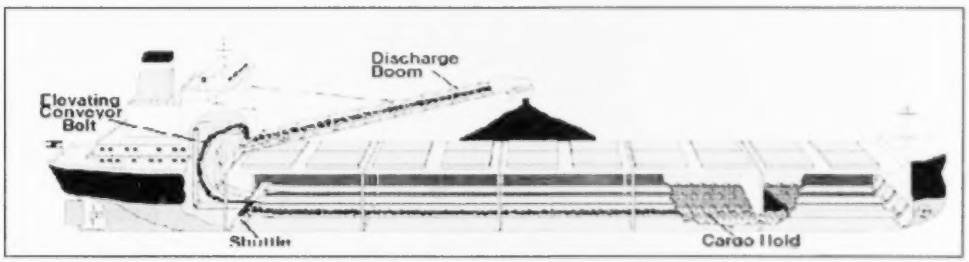
4.0 INFRASTRUCTURE

4.1 Equipment



- In-pit infrastructure includes excavators, loaders, haul trucks, rock crushers, screening and washing equipment, conveyor systems, stock pile areas, and loadout equipment for tucks, barges or ships.
- Operations require power, water, fuel storage facilities, communications, utilities, security and most importantly competitively cost transportation to the customer (e.g., tidewater access).
- The main public infrastructure used by the aggregate industry is the road and highway system used to transport aggregates, ready mix concrete and asphalt to the construction site.
- Most construction aggregates in BC are transported by barge and truck – there are more than 8 major barge loading sites, two ship loading sites, and at least 6 barge unloading sites in the Southwest BC coast market area – which are privately owned.[14]
- Over the last few years, self-unloading Panamax class ships (i.e., sized to fit the Panama Canal) have been used to haul BC aggregates to California.
- Canada Steamship Lines (CSL) ships transport gypsum from Cabo San Lucas, Mexico, to Texada Island and Puget Sound (for drywall manufacturer) – the current export of sand, gravel, and lime rock to from BC California, is a back haul on these vessels.

4.2 Schematic of Self-Unloading Ship



- In the Interior and Northern regions of BC, aggregate operations are limited by rain, snow, and ice to the warmer months of the year, and so aggregate is typically stockpiled for the winter months along road and highway routes.

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

5.0 MARKETS

5.1 Major Aggregate Users

- Municipalities are the largest users of aggregates.
- The Lower Mainland makes up about half of the BC aggregate market and about 65% of the concrete aggregate market.[15]
- The largest aggregate producers in BC are cement companies – Lehigh, Lafarge and Ash Grove – the Sunshine Coast deposits generally supply the western part of the GVRD, about one third of the demand, which is shipped by barge and truck – truck haul distances for barged material ranges from 0 to 40 km.
- The main source of sand and gravel in the GVRD is from Coquitlam and Abbotsford[16] – dredged sand from the Fraser River makes up about ¼ of the aggregate supply in the GVRD.[16]
- The average load by truck in the Vancouver area is about 17 tonnes – dump truck and trailer combinations can carry 28 tonnes, and a bottom dump truck and trailers can carry about 40 tonnes – barge capacities generally range between 3,000 to 8,000 tonnes/load – a Panamax ship can carry up to 60,000 to 70,000 tonnes/load.

5.2 Quality Specifications

- BC's largest quarries may produce up to 16 standard products and over 40 blends – impurities such as clay and fines must be removed by washing – screening, blending and crushing are necessary to meet concrete, asphalt and road base specifications.[17]
- A cubic meter of concrete requires about 1.2 tonnes of coarse aggregate (stone), 1.0 tonne of fine aggregate (sand), 0.25 tonnes of cement and 0.11 tonnes of water.
- Concrete aggregate generally should not contain rocks that unfavorably react with cement such as gypsum, pyrite, chert, shale, and high silica volcanic rocks – the general types of rocks in the aggregate (sedimentary, metamorphic or igneous) and the specific subcategories of rocks, and their suitability for concrete may be determined by a petrographic analysis.
- Asphalt mixes can accept more fines than concrete, but generally require a narrower size range distribution.
- Quality parameters are set by the aggregate buyer for their specific uses or the Canadian Standards Association,[18] the BC Ministry of Transportation and Highways, Transport Canada, Master Municipal Construction Documents (MMCD) and the State of California Department of Transportation (CalTrans – for export sales).

© 2003 Ministry of Sustainable Resource Management

- The aggregate specifications can be fairly detailed, including consideration of the following:

➤ Gradations – the percent material in each screen size range must be within specified limits. ➤ Cleanliness – no dirt or clay or undesirable contamination. ➤ Consistent uniform product. ➤ Concrete pumpability – requires smoother gravel.	➤ Moisture content – typically about 5.0 percent. ➤ Specific gravity and bulk density – typically about 1.9 tonnes/m^3. ➤ Durability of constituents. ➤ Shape of rocks and freshness of particle surfaces. ➤ Reliability of supplier.	➤ Strength of concrete or mortar produced. ➤ Concrete shrinkage limits met. ➤ Purity-Free from reactive components. ➤ Strength of rocks. ➤ Chemical resistance.

- The pit or quarry geology and material extraction process greatly influences processing requirements and costs and product quality – key quality and feasibility factors are location and quality.
- The best deposits are located where they are found – so any aggregate deposits (e.g., zoned for that purpose) may not be where the best material is located and may never be used.

5.3 Aggregate Prices

- Although, aggregate prices vary by the required processing steps, a greater factor affecting delivered price is transportation cost – transportation costs are influenced by the distance between the pit and customer and by the transporation means, – truck, barge and ship – generally the larger the shipment size, the lower is the per unit transportation costs.
- Crushed rock is more costly to produce than pit-run sand and gravel or dredged sand and byproduct sand and rock.
- The growth rate for crushed stone is about 1.0 percent/yr. and for sand and gravel about 0.5 percent/yr.[8] – in the Lower Mainland there are usually one or more projects each year that represent a sizable portion demand.
- Asphalt ranks as the top recycled product in North America – it is estimated that 80 percent of asphalt pavement is now recycled.[19]
- Crushed rock is used to meet higher quality specifications and to make up shortages of required gravel in many pits.
- With the increased densification of the Lower Mainland population, more concrete construction is occurring, which uses more aggregate as compared to traditional wood and lower density construction.

© 2003 Ministry of Sustainable Resource Management

6.0 EMPLOYMENT

- Many of the 120,000[20] construction jobs in BC are directly dependent on aggregate production, including road builders, cement and concrete manufacturers, concrete product manufacturers, concrete finishers, truck drivers and many building trades.
- Commercial aggregate operations directly employ more than 3,000 workers in BC – with the addition of Ready Mix and asphalt plants; direct employment is estimated to be about 5,350 workers.
- With the addition indirect employment (employment generated by the suppliers to the aggregate industry) and induced employment (employment created by the respending of employment income), the total employment generated by the aggregate industry is about 8,500 jobs, based on the 1996 BC Input-Output Model.[21]

6.1 Total Employment

	Employment	Total Workers
	Worker /$million/yr. sales[22]	
Direct Employment		
Crushed Rock	6.4	314
Sand And Gravel	6.9	1,125
Further Processing		350
Trucking		1,250
Ready Mix Concrete		1,813
Asphalt Plants		500
Direct Employment		5,352
Indirect Employment[19]		1,927
Induced Employment[19]		1,172
Total Employment		8,451

7.0 RESOURCE CAPACITY

- In general, BC has abundant supplies of construction aggregates, however they are not equally distributed and there are regional shortages (e.g., parts of Northeast and Northwest) – shortages of aggregates result in higher prices – for example, shortages in Prince Rupert requires a 150 kilometer truck haul from Terrace at an additional haul cost of $13.00/tonne (added to the cost at the pit).
- Many major aggregate suppliers typically have a 20-year or more reserve – many smaller available pits are used only intermittently (during the warmer months).
- Aggregate production can be constrained by Land Act provisions that prohibit the sale of Crown land for aggregate production – the non-ownership status of the land and cost of land tenure can impose operating and investment constraints.
- Inventories of non-bedrock aggregate supplies have been conducted for the Lower Mainland, Prince George, Central Okanagan and Nanaimo areas – one objective of these

© 2003 Ministry of Sustainable Resource Management

inventories is to maintain production sites as close to market as possible, while avoiding or minimizing land and road use conflicts.

- The general long-term trend is that aggregate prices are steadily increasing in populated areas, reflecting restrictions on existing operations and difficulties in obtaining approval of new operations – factors that increase transportation distances, which in turn drives up the cost of delivered aggregate.
- Since municipalities are the largest users of aggregates, higher delivered costs will be reflected in higher property taxes to maintain the same level of public service.
- The Aggregate Producers Association of BC have suggested that local governments and certain Crown agencies be required (e.g., through Official Community Plans) to identify long-tern aggregate reserve areas (30 to 50 years), which would help keep property tax increases to a minimum.

8.0 REGULATION

8.1 Provincial Approvals

- Guidance on complying with the various statues and permits that may be required for a new pit or quarry is provided in the Aggregate Operators Best Management Practices Handbook for BC.[7]
- The *Environmental Assessment Act* established BC's environmental review process, coordinated by the Environmental Assessment Office, which reviews the potential environmental, social, economic, cultural, and heritage impacts of large-scale development projects.
- Reviewable projects include metal, mineral, coal and placer mines, aggregate operations and industrial quarries (e.g., crushed rock, dimension stone), offshore mines, in addition to related processing of primary metals, minerals and mineral products and manufacturing (cement, glass, lime and asbestos).
- The BC environmental review process accommodates simultaneous review of the required permits and licences – application of permits and licences may need to incorporate detailed engineering design information, which may be difficult to justify without first approving approval-in-principle through environmental assessment approval.
- Provincial statues and regulations[23] that may apply to aggregate operations, include: the *Mines Act* (Health, Safety and Reclamation Code), *Forest Land Reserve Act*, *Forest Act*, *Range Act*, *Forest Practices Code Act*, *Soil Conservation Act*, *Agricultural Land Reserve Act*, *Land Act*, *Highway Act*, *Water Act*, *Heritage Conservation Act*, *Environmental Assessment Act*, *Fish Protection Act*, *Waste Management Act*, *Wildlife Act*.
- Most aggregate produced in BC is from private land – First Nations also wholly or partly own some pits and quarries – production from Crown land requires leases to be obtained under the *Land Act*.
- Aggregate is not a mineral under the *Mineral Tenure Act*, and therefore there is no mineral tax – but gravel pits and quarries are regulated under the *Mines Act* – permits include security requirements to ensure proper reclamation once operations are completed.

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

8.2 Federal Approvals

- When a large scale aggregate project triggers the *Canadian Environmental Assessment Act* (>1.0 million tonnes/yr.), the BC and Federal governments have agreed to co-operate in a joint review process – Federal statues relate mainly to environmental protection and federal assets – at the end of a Federal-Provincial review, each government makes a separate decision on the project.
- Federal involvement can be triggered when projects require interprovincial or international or otherwise federal approvals, which receive federal finanacial assistance, or involve federal lands.
- Federal statues and regulations[24] that may apply, include: the *Fisheries Act*, *Canadian Environmental Assessment Act* (projects >1 million tonnes/yr.), the *Navigable Waters Protection Act*, *Canadian Environmental Protection Act*, *Migratory Birds Convention Act*, *Canada Wildlife Act*.

8.3 Local Approvals

- Municipalities regulate aggregate operations on private land through application of local bylaws that can affect soil removal, hours of operation, noise, truck transport routes, and other operating conditions.
- In parts of the Lower Mainland gravel processing is prohibited – Langley does not allow soil removal, including sand and gravel, except in small quantities.
- The Minister of Municipal Affairs and the Minister of Energy and Mines approve municipal bylaws that affect aggregate extraction – while aggregate extraction is not a land use subject to zoning, municipal bylaws and zoning can apply operating restrictions – limitations on the duration of an aggregate lease can affect decisions related to investment (e.g., increases perception of business risk to the creditor).
- Local bylaws[25] and other requirements that may apply at the local level, include: the *Local Government Act*, Community Charter, *Soil Conservation Act*, *Growth Strategies Act*, Memorandums of Agreement, Official Community Plans, Bylaws, Soil Removal Bylaws and fees, Zoning, Subdivision and Servicing Development, Noise by-laws, Tree Retention, Commercial Vehicles, Business Licenses.

8.4 Approval Lead Time

- Timelines for the government portion of BC environmental assessment review is set out in regulation – the length of the review process depends on the complexity of the issues and could range from 12 to 30 months, or longer is a public hearing is required.
- The Aggregate Producers Association of BC have indicated that obtaining approvals for a new large deposit can take over 5-years and cost in excess of $1,000,000 – cost that must be recouped from the consumer (the biggest consumers being local government).

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

9.0 GOVERNMENT REVENUES

- Aggregate businesses are subject to fees and taxes, similar to other businesses – the main additional charge for aggregate operators on private land is a soil removal fee charged by most municipalities in populated areas – in some areas, such as Delta, this is referred to as an "environmental levy".
- The courts have ruled that these fees must be related to direct costs of the aggregate operation on the municipality – therefore, revenues raised by the municipal fees can only be spent on the maintenance of roads impacted by aggregate truck traffic.
- Aggregate operators on Crown land pay a royalty based on the market value of the aggregates – for example, on parts of Vancouver Island the royalty is $0.90/tonne, but can range up to $1.50/tonne.[26]
- The following table lists the various local, provincial and federal taxes and levies related to the production and transporation of aggregate industry in BC.

Municipal
Business License Fees
Property Taxes
Soil Removal Fees

Provincial
Employee Income Taxes (40k/worker, 7%)
Crown Lands- Land Rent Fee
Crown Lands- Aggregate Royalties
Provincial Sales Tax (7.5%)
Corporate Income Tax- (13.5%)
WCB (0.33% wage rate)
Fuel tax

Federal
Employee income taxes (40k/worker, 14%)
Employment Insurance (3.15%)
Corporate income taxes (26.12%)
Goods and Service Tax (7.0% on margin)
Federal Excise Tax on fuel

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

10.0 INPUT-OUTPUT COEFFICIENTS

10.1 Demand Coefficients [27]

- The demand for aggregates and the derived demand for land and labor are driven by the needs of new construction (e.g., roads, infrastructure and buildings) and the maintenance of existing infrastructure, as illustrated below

Roads	18,500	tonnes/km
Residences- Vancouver	83	tonnes/unit
Residences Fraser Valley	166	tonnes/unit
Commercial Construction	0.063	tonnes/ft.^{2}t
Low Rise Multi Family Homes	20	tonnes/unit

10.2 Employment Coefficients [28]

Employment/million sales /yr at pit	Direct	Indirect	Induced	Total
Quarry and Sand Pit Industries	6.67	2.38	1.46	10.51
Concrete Products Industry	10.17	4.27	1.69	16.13
Truck Transport Industry	8.88	4.07	1.51	14.46

- The BC Input-Output Model employment coefficients of the aggregate industry and related industries (concrete products and trucking) indicate there are 10.5 to 16.1 total jobs per $1,000,000 in sales revenues.
- Total Employment – is the sum of this total economic activity, (i.e., direct and spin-off impacts) composed of three components (direct, indirect and induced).
- Direct Employment – is the employment associated with the direct activity of the aggregate and related industries in BC, identified in the Section 6.0 Employment.
- Indirect Employment – is the employment generated within the BC economy from suppliers of the materials (goods and services) required to produce BC aggregate and related products for the domestic and export market.
- Induced Employment – is generated from the suppliers paying out wages to their employees, which are then respent in the economy (net of savings and taxes).

Note: revised February 7, 2003

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

SOURCES OF INFORMATION

[1] This Building Block is one of five prepared under the *Minerals, Coal and Aggregates Building Block* heading, which covers Construction Aggregates, Industrial Minerals, Metal Mines, Coal and High Valued Opportunities.

[2] Pers. Comm. Brian Weeks, P.Eng, President of the Aggregate Producers Association of BC. October 24, 2002.

[3] BC Ministry of Energy and Mines (2001) "*Managing Aggregate, Cornerstone of the Economy Report of the Aggregate Advisory Panel,*" March 2001and Statistics Canada www.nrcan.gc.ca/mms/cmy/content/39.pdf. Population for per capita figures: BC Stats Municipal Population Indicators, January 2001 http://www.bcstats.gov.bc.ca/pubs/bcbi/bcbi0101.pdf

[4] BC Ministry of Energy and Mines (2001) "*Managing Aggregate, Cornerstone of the Economy Report of the Aggregate Advisory Panel,*" March 2001.

[5] BC Ministry of Energy and Mines (2001) "*Managing Aggregate, Cornerstone of the Economy Report of the Aggregate Advisory Panel,*" March 2001, page 1, and BC Stats Municipal Population Indicators, January 2001, http://www.bcstats.gov.bc.ca/pubs/bcbi/bcbi0101.pdf.

[6] BC Forests, *Annual Report, 1999-2000* www.fot.gov.bc.ca/pub/publctns/an_repts/9900/AR1999_2000.pdf Based on 43,000 km of Forest Service roads and one intermittent pit per 10 km. Also BC Forests, Resource Tenures & Engineering Branch, "*Discussion Paper, A Framework For Managing Forest Service Road,*" Oct., 1998. Based on 127,000 km of operational roads and one intermittent pit per 10 km.

[7] BC Ministry of Energy and Mines (http://www.em.gov.bc.ca/Mining/MiningStats 2002 http://www.em.gov.bc.ca/Mining/Geolsurv/Surficial/aggproj.htm Nov. 01, 1999 http://www.em.gov.bc.ca/Mining/Geolsurv/Surficial/agginv.htm Nov. 1, 1999

[8] US Geological Survey http://minerals.er.usgs.gov/minerals

[9] BC Ministry of Energy and Mines, "*Aggregate Operators, Best Management Practices Handbook for British Columbia,*" April, 2002 www.em.gov.bc.ca/Mining/MiningStats/55AOBMPHand_pdf.htm

[10] Consedine, R., *Aggregate & Roadbuilders Magazine*, "*Sechelt Upgrades For High Tonnage Aggregates Production,*" Montreal, 2000. http://www.rocktoroad.com/article3.htm

[11] *Aggregate & Roadbuilders Magazine* (January-February 2002) pages 12 & 13. Canadian Steamship Lines' has put in service three new Panamax, "S" class, 60,000-dwt bulk carriers with self-discharging belt unloaders capable of discharging an entire shipment in 30 hrs.

[12] BC Aggregate Producers Association of BC, Surrey http://www.gravelbc.ca/index.htm Memo to G. Bridges from Brian Weeks, P.Eng, President of the Aggregate Producers Association of BC. October 24, 2002.

[13] *Aggregate & Roadbuilders Magazine* http://www.rocktoroad.com/robust.html. And Applied Economic Developments, Berkeley, CA, Report for the Construction Materials Association of California, "*The Aggregates Industry: It's Importance to California's Economy and Infrastructure,*" Sept. 2001.

[14] US Geological Survey Swanson, Diane, "*Barging Aggregates Along Canada's Pacific Coastline,*" Canadian Aggregates, Sept.-Oct., 1991

[15] BC Employment & Investment, Levelton Engineering Ltd., *Lower Mainland Aggregates Demand Study* June 19, 1996 www.em.gov.bc.ca/dl/mog/leveltonreport.pdf

© 2003 Ministry of Sustainable Resource Management
Economic Development Branch

[16] Memo to G. Bridges from Brian Weeks, P.Eng, President of the Aggregate Producers Association of BC. October 24, 2002.

[17] Consedine, R., Aggregate & Roadbuilders Magazine, "*Sechelt Upgrades For High Tonnage Aggregates Production,*" Montreal, 2000. http://www.rocktoroad.com/article3.htm.

[18] CAS-A23.1-M90 Concrete Materials and Methods of Concrete Construction" and CSA-A23.2-M90.

[19] Aggregates & Roadbuilding http://www.rocktoroad.com/asphaltrankstop.html, also BC Employment & Investment, Levelton Engineering Ltd., "*Lower Mainland Aggregates Demand Study*" June 19, 1996 www.em.gov.bc.ca/dl/mog/leveltonreport.pdf.

[20] BC Stats (2001) *An introduction to BC's Economy* February, 2001 http://www.bcstats.gov.bc/pubs/bcbi/bcbi0102.pdf.

[21] BC Ministry of Finance and Corporate Relations (2001), *British Columbia Provincial Economic Multiplies and How to Use Them*. Large aggregation Page 16.

[22] Stats Canada Employment Table 281-0005 SIC Code 1980 Stone quarries, sand and gravel pits, and ready mix concrete industry http://cansim2.statscan.ca US Geological Survey Production, price and employment and data for 2000 http://minerals.usgs/minerals/pubs/commodity/stone_crushed/630302.pdf and http://minerals.usgs.gov/minerals/pubs/commodity/sand_&_gravel_construction/59032.pdf

[23] Provincial statutes http://www.qp.gov.bc.ca/statreg/

[24]Federal statutes http://laws.justice.gc.ca/en/index/index.html

[25] Local government links http://www.civicnet.gov.bc.ca/members/municipalities/index.html

[26] Memo to G. Bridges from Brian Weeks, P.Eng, President of the Aggregate Producers Association of BC. October 24, 2002.

[27] BC Employment & Investment, Levelton Engineering Ltd., "Lower Mainland Aggregates Demand Study" June 19, 1996 www.em.gov.bc.ca/dl/mog/leveltonreport.pdf

[28] BC Ministry of Finance and Corporate Relations (2001), *British Columbia Provincial Economic Multiplies and How to Use Them*. Large Aggregation Industries, Induced assumes "with Safety Net". Coefficients for the BC asphalt industry not available.

© 2003 Ministry of Sustainable Resource Management